Aaryn D. Jones

University of North Carolina at Chapel Hill, Chapel Hill, NC

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Nanoscale Chemistry Platforms in Perfluoropolyether-Based Microfluidic Devices

Environmental Issue

- Why Use Microfluidic Technology?
  - Potential to greatly reduce organic solvent consumption (currently 177 million pounds waste generated yearly by pharmaceutical manufacturing alone[1])
  - Interesting dynamics in yoctoliter (10^{-24}) scale volumes
  - Increase application speed ~10^2
  - Potential for automation
  - High quality data

- Applications of Microfluidics
  - Inkjet printing technology
  - Medical diagnosis
  - Genetic sequencing
  - Drug discovery
  - Fuel cells
  - Chemical process engineering
  - Environmental sensors

www.devicelink.com/ivdt/archive/00/11/008.html

Scientific Approach

- Hypothesis: Perfluoropolyether (PFPE) devices will outperform traditional polydimethylsiloxane (PDMS) materials in organic solvent microfluidic applications

PDMS

Advantages

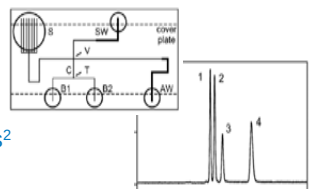
- Elastomeric material→ conforms to surfaces and forms reversible seals
- Low surface energy→ allows easy release from molds after patterning
- Good gas permeability→ ability to sustain living cells inside features

Disadvantages

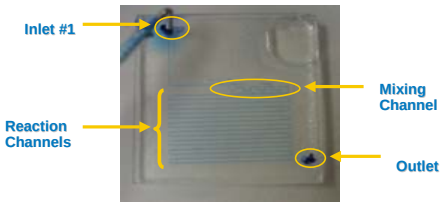
- Readily adsorbs hydrophobics from solution
- Surface is relatively nonpolar→ low wetting capability with water
- Surface has no ionizable groups→ impossible to generate electroosmotic flow
- Swells in organic solvents

PFPE

- Research Goals:
  - Perform a suite of reactions in PFPE and PDMS devices
    - Compare device performance and reaction yield
  - Perform multiple operations on one PFPE chip
    - Single chip filtration, concentration, separation, and detection of four PAH's[2]



PFPE Microfluidic Reactor



Impact

- Use of PFPE as a device material opens the door for commercially viable microfluidic organic solvent applications
  - PFPE is easy to fabricate and inexpensive compared to silica-based devices
  - PFPE is chemically resistant towards organic solvents
  - PFPE devices could potentially replace macroscale organic solvent processes, thus drastically reducing organic solvent consumption and waste generation
- Development of PFPE material to construct inexpensive environmental sensors

(1) http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/pharmapt2.pdf

(2) Broyles, *Anal Chem*, 2003, 75, 2761.

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